# Binary Asset-or-Nothing Option

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### 1 Inputs to Function

Description	Symbol	min	max	$Reasonable\ range$
Underlying	S	$0^{+}$	$+\infty$	
Strike	X	$0^{+}$	$+\infty$	
Continuous risk-free interest rate till $T$	r	$0^{+}$	$+\infty$	
Continuous secondary rate till $T$	q	$0^{+}$	$+\infty$	
Volatility till $T$	$\sigma$	$0^{+}$	$+\infty$	
Time to maturity	T	$0^{+}$	$T_s$	
Continuous secondary rate till $T_s$	$q_s$	$0^{+}$	$+\infty$	
Time to settlement	$T_s$	T	$+\infty$	
Put or Call	indicator	_	_	"P", "C"

### 2 Formula

Haug  $(1998)^1$  states that *binary asset-or-nothing* options can be valued using the Cox and Rubinstein  $(1985)^2$  formula. Our Risk Engine uses the following pricing formula, which includes the settlement period,

where

$$f = Se^{-q_s T_s} N(\phi d_1),$$

$$d_1 = \frac{\ln \frac{S}{X} + \left(r - q + \frac{\sigma^2}{2}\right)T}{\sigma\sqrt{T}}.$$

$$\frac{\phi \quad \text{Option Type}}{-1 \quad \text{Put}}$$

$$1 \quad \text{Call}$$

## 3 Properties of Instrument

A binary asset-or-nothing option pays out the value of the underlying at settlement  $S_{T_s}$  if the option expires *in* the money, as illustrated in Table 2 and Figure 1. A call option expires in the money if  $S_T > X$  and a put option expires in the money if  $S_T < X$ .



<sup>&</sup>lt;sup>1</sup>Haug (1998) p.90, 2.11.4 Asset-or-Nothing Options

 $<sup>^2\</sup>mathrm{Cox}$  and Rubinstein (1985) p.460 8.4 The Superfund

Option Type	Condition	Payoff
Call	$S_T > X$ $S_T \le X$	$S_{T_s} \ 0$
Put	$S_T \ge X$ $S_T < X$	$0 \\ S_{T_s}$

Table 2: Payoff at settlement for binary asset-or-nothing option



Figure 1: Payoff at maturity for binary asset-or-nothing option

## Bibliography

John Cox and Mark Rubinstein. Options Markets. Prentice Hall, Englewood Cliffs, New Jersey, 1985. Espen Gaarder Haug. The Complete Guide To Option Pricing Formulas. McGraw Hill, New York, 1st edition, 1998.

## Glossary

 ${\bf Risk} \ {\bf Engine} \ {\rm The \ Vector \ Risk \ market \ risk \ and \ credit \ risk \ system.}$